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PYRITE RECOVERY BY COLUMN FLOTATION FROM RIO ALGOM LIMITED URANIUM LEACH TAILS

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PYRITE RECOVERY BY COLUMN FLOTATION FROM RIO ALGOM LIMITED URANIUM LEACH TAILS

by

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SUMMARY

An investigation was carried out on the applicability of column flotation technology to the recovery of pyrite from uranium tails. Four drums of settled tails samples were received from the Rio Algom Process Development Department. This material was then used for 8 flotation runs needed to satisfy the requirement for a 2^3 factrial design test. The objective was to test three parameters (collector addition rate, pH and retention time) and to obtain initial information for process optimization.

Test results confirm the applicability of column flotation to the product under investigation. Over 90% pyrite recovery was achieved with the concentrate produced in a single step containing over 35% Fe and representing approximately 6% weight of the original feed.

Keywords: column flotation, pyrite recovery, uranium tails

TEST PROCEDURE

Four 45 gallon drums of uranium leach tails samples were received for pyrite flotation tests using column flotation technology.

Each sample drum contained approximately 150 kg of settled solids in a plastic bag covered by approx. 25 cm of water. The following test procedure was used:

- water from the drum was decanted and stored.
- a calculated amount (36.4 kg) of wet solids was taken out of the drum.
- 25L of decanted plant water and 25 L of tap water were placed in the agitator tank.
- weighed out wet solid (36.4 kg) was added to agitator to give 70 L of 35% solids slurry.
- pH was checked and if needed adjusted with $H_2 SO_4$.
- measured amount of 1% solution of potassium amyl xanthate and MIBC were added to the slurry.
- column was filled up with water, wash water was opened
- tail pump output was adjusted according to the retention time planned for the run.
- feed pump output was adjusted and column feeding commenced.
- after approximately 30 - 45 min. sampling started and was conducted as follows:

    - 200 mL of feed slurry every 5 min.
    - 200 mL of tails/5 min.
    - concentrate overflow pipe was directed into sample bucket
    - sample taking lasted 30 min.
    - feed and tails flowrates were measured

- end of run: agitator tank and column drained and washed.
- samples were filtered, dried, prepared and sent out for analysis for:

  Total sulphur,
  Sulphide sulphur,
  Iron

It was noticed that the material taken from the top of the drum was finer than that found at the bottom where a certain amount of coarse particles was present, including ¼ " pieces. Additional screening step on 10 mesh screen was then required.

The influence of feed size ditribution is not included in the interpretation of test results.

EXPERIMENTAL

The effect of three factors on pyrite recovery was investigated:
A - Xanthate addition
B - pH
C - retention time

As each factor was tested at two levels, a 2^3 factorial design test was carried out. Such testing requires a minimum of 8 unreplicated runs to give basic information on main and interaction effects. The following levels were tested:

Xanthate addition	: high	0.17	lb/t	+
	low	0.07	lb/t	-
pH	high	8.6		+
	low	5.0		-
retention time	high	21.7	min.	+
	low	13.0	min.	-

The runs conducted are illustrated in Table 1

Table 1:

RUN	A	B	C
1	+	+	+
2	–	+	+
3	+	–	+
4	–	–	+
5	+	+	–
6	–	+	–
7	+	–	–
8	–	–	–

Sequence of runs was random.

RESULTS

The chemical analyses are presented in Table 2:

Table 2:

	FEED			CONCENTRATE			TAILS		
RUN	%Fe	%S	%S.S*	%Fe	%S	%S.S*	%Fe	%S	%S.S*
1**	2.95	3.79	3.24	7.30	9.37	8.27	4.80	6.35	5.44
2	1.85	4.11	1.75	21.20	36.24	29.46	1.02	2.39	0.43
3	2.38	3.93	2.85	25.30	31.97	31.73	0.49	1.14	0.17
4	2.72	3.51	2.99	37.20	45.89	45.85	0.58	0.81	0.21
5	1.98	3.82	2.15	29.90	42.92	40.31	0.70	1.66	0.30
6	1.60	3.52	1.96	36.80	51.48	51.21	0.78	1.66	0.32
7	2.29	4.06	2.59	29.98	36.20	36.09	0.54	1.43	0.32
8	2.90	3.48	3.17	37.60	48.78	48.72	0.40	0.55	0.36

* Sulphide sulphur

** Due to the shortage of test material Run 1 was deficient and the results will be disregarded.

Weights of concentrates were calculated using sulphide S assays in the two product formula: $\% \text{ Wt } C = 100. \frac{f-t}{c-t}$ for each run and are shown in Table 3.

Table 3:

RUN N.	Wt% in concentrate
1	—
2	4.55
3	8.49
4	6.09
5	4.62
6	3.22
7	6.35
8	5.81

Two treatment responses were investigated:

- Sulphide S% content in tails
- Sulphide S% recovery in concentrate

To estimate the main effects of factors and the interaction effects of two and three factors, Contrast Co-efficients for 2^3 Factorial Design are used as presented in Table 4 for suphide S% in tails (Ta) and for sulphide S% recovery (Tb).

Table 4:

ROW	(1)	(2)	(3)	(12)	(13)	(23)	(123)	TREATMENT TOTALS Ta	Tb
1	+	+	+	+	+	+	+	——	——
2	–	+	+	–	–	+	–	0.43	76.55
3	+	–	+	–	+	–	–	0.17	94.54
4	–	–	+	+	–	–	+	0.21	93.40
5	+	+	–	+	–	–	–	0.30	86.69
6	–	+	–	+	+	–	+	0.32	84.20
7	+	–	–	–	–	+	+	0.32	88.43
8	–	–	–	+	+	+	–	0.36	89.30

Estimated main effect of factor is: $\frac{Ta}{7}$ or Tb

Estimated values of effect are presented in Table 5 for %Sul. 5 in tails.

Table 5:

MAIN EFFECTS	TWO FACTOR INTERACTIONS	THREE FACTOR INTERACTIONS
X_1 – 0.08	$X_1 X_2$ – 0.07	$X_1 X_2 X_3$ – 0.06
X_2 – 0.001	$X_1 X_3$ – 0.06	
X_3 – 0.05	$X_2 X_3$ 0.02	

Table 6 presents estimated values of effects for % recovery of Sul. S in concentrate.

Table 6:

MAIN EFFECTS	TWO FACTOR INTERACTIONS	THREE FACTOR INTERACTIONS
X_1 - 10.54	$X_1 X_2$ - 10.62	$X_1 X_2 X_3$ - 11.58
X_2 - 16.89	$X_1 X_3$ - 11.00	
X_3 - 12.02	$X_2 X_3$ 14.94	

CONCLUSIONS

1. Column flotation can very effectively remove pyrite from the uranium leach tails. Under the right set of conditions pyrite recovery of over 90% can be obtained.

2. A single stage flotation produces pyrite concentrate which contains over 35% Fe and represents approximately 6% weight of the original feed.

3. pH level has the strongest effect on the pyrite recovery.

4. Xanthate addition and pH have the most significant combined effect on the pyrite left in tails while retention time and pH affect most strongly pyrite recovery.

5. Optimum conditions for flotation of pyrite from this sample appear to be:

Xanthate addition	---	0.17 lbs/t
pH	---	5.0
retention time	---	21.5 min.